Fertilizer Application on Immature Rubber. The case of Clone PB 330 in Tboung Khmum Province, Cambodia

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Abstract

Fertilization is one of the most important factors that affect growth and yield of rubber tree. It takes a high rate of capital investment for plantation. Regulation on fertilizer quantity or/and ratio among fertilizer nutrients results in remarkable economical and technical impacts on the rubber plantation during the immature period. During the mature period, data are still controversial. This experimental study aimed to evaluate the effects of fertilizer on the rubber growth in immature stage. After seven years of experimentation, results showed that fertilization had a positive effect on the cumulative girth increment (cm) by 6% whereas the tapped rubber trees at opening increased by 7 to 13%.

Keywords: Rubber tree, immature period, fertilizer

1. Introduction

Rubber tree (Hevea brasiliensis Müll. Arg.) is among the major tropical economic tree crops of the world. Originating from the Amazonian tropical rainforests, rubber is intrinsically suitable for climates that are warm and moist throughout the year (Priyadarshan, 2003; Priyadarshan et al., 2005). Rubber was among the top priority crops for Cambodia; it is expected to be the second leading income earner after rice paddy in the future. Up to end of 2018, the country has 436,684 hectares of rubber plantations, most of them are immature rubber, which have not yet yielded, according to the statistics of General Directorate of Rubber. Increasingly, the loss of community-based resources such as non-timber forest products and agricultural land must be weighed against the economic benefits, as rubber cultivation provides for the livelihoods of smallholders and their workers, together numbering in the millions (Simien and Penot, 2011).

Many studies have reported that fertilizer is one of the most important factors that obviously improves growth and yield of rubber tree; but at the same time, it takes a high rate of the capital investment for plantation (Ngo Thi Hong Van *et al.*, 2001, Vrignon-Brenas *et al*., 2019). Particularly, economical and sustainable rubber plantation enterprises depend largely on high rate of fertilizer supplementation because rubber is a high nutrient demanding crop especially during the immaturity phase of their growth and development (1 - 6 years). Therefore, optimum rubber growth and high-quality latex output therefore depend largely on the ability of the farmer to determine controlling factors and properly adjust them to suit rubber production. As a consequence, any regulation and optimization of fertilizer quantity and/or ratio among fertilizer nutrients will result in remarkable economical and technical impacts on the rubber plantation during the immature and mature periods.

A major factor in any plant growth is the soil as it determines the availability of nutrients required by the plant (J. R. Orimoloye *et al*., 2010). For rubber trees that are grown on a nutrient deficient soil, the effect of fertilizer application could be seen in short time that is one year or less (Ismail, 1981). Manuring recommendation is mainly based on the requirement of macro nutrients N, P, K, and Mg (Adiwiganda *et al*., 1994), while the requirement of micro nutrients is considered small and usually satisfied by the soil. The role of micronutrients gets less attention on rubber trees (Yogaratnam and Perera, 1985). To improve the understanding of the potential impacts of fertilizer on rubber, the objectives of this study were to determine effect of fertilizer on rubber growth during immature period.

2. Materials and Methods

Site description:

The experimental site is located in the Cambodian Rubber Research Institute (CRRI). The experimental rubber plantation is on a level plain set in red basaltic latosols. The soil texture is clay with about 5.17% fine sand, 11.51% coarse silt, 11.10% fine silt, 1.91% coarse sand and 68.60% clay.

Climate:

The climate is governed by the Asian monsoon, which produces two distinct seasons: a wet season (approximately May–October) and a dry season (approximately November–April). Annual precipitation in 2010 to 2017 was respectively of: 1247, 1511, 1745, 1467, 1726, 1225, 1646 and 2265 mm, Rainy seasons extended from late-May to late-November in 2010, and late-April to mid-November in 2011. The mean annual temperature in 2010 to 2017 was respectively of: 28.1, 27.2, 27.9, 28.2, 27.6, 28.0, 30.4, and 27.4 °C.

Planting device:

Rubber trees, clone PB 330 were planted in 2010 using a regular spacing of 6 m in north-south direction and 3 m in east–west direction, resulting in a potential tree density of 555 trees·ha^{-1}. The experiment was arranged in randomized block design with 4 treatments and 4 replications with 50 trees per plot. The experiment was conducted from the first year of planting until seventh year.

Fertilizer application:

Three doses of fertilizer were compared to a non-fertilized control. The formula was NPK 15-15-15 with different doses (Table 1).

Fertilizers were applied two times per year, in May and October during 4 years. During the first year after planting, the fertilizer was applied in a circle, free of weeds, at 25-30 cm from the base of the plant and round it with light forking. The radius of this circle was increased with age, up to about 100-120 cm at the end of the 4^{th} year.

Soil chemical analyses:

The soil carbon (C) analyzed by Black method (and organic matter = 1.72×C). Soil nitrogen (N) was analyzed by the Kjeldalh method. Soil P available was analyzed by Olsen method.

Soil exchangeable K was analyzed by flame spectrophotometer and atomic absorption spectrophotometer (Black, C.A.,1965).

Observed parameters:
Growth was monitored 2 times per year by recording the girth of the trees at a height of 1m from the ground and the height was measured 1 time per year.

Table 1. Annual doses of 15-15-15 fertilizer per treatment during the four first years of immature period (in g·tree^{-1}·year^{-1})

Treatments	Years after planting			
	1st	**2nd**	**3rd**	**4th**
T0	0	0	0	0
T1	140 g	140 g	210 g	280 g
T2	200 g	200 g	300 g	400 g
T3	300 g	300 g	450 g	600 g

3. Results

Soil nutrient

The soil nutrient contents before the implementation of treatment are shown in Table 2.

Table 2. The soil nutrient content before planting

Parameter	pH (H_2O)	C	N	P available	K	C/N ratio
Unit		*%*	*%*	*ppm*	*meq/100 g*	
Value	4.60	1.45	0.175	164	0.53	8

These values indicate that the soil is highly acid. The organic matter is low (low C) and it seems that it does not decompose easily as shown by the low C:N ratio (optimum is 10 to 12), which is often the case in strongly acidic soils.

On the other hand, the P and K nutrients quite high and well above the thresholds required for this crop that are respectively of 10 ppm and 0.11 meq/100 g (Suchartgul, 2012).

Girth increase during immature phase

The fertilizer rates increased rubber growth in girth size. Naturally, the rubber girth size is very important because it determines the yield of the plant in terms of latex flow and its quality. The growth was generally increased and significantly different in 3 years after planting. The rubber girths of all treatments were similar at 1st and 2nd year of planting and were significant difference at 3rd year to 6th year (Table 3).

Table 3. Annual girth and girth increments in immature period from year 1 to year 6 (in cm).

Treatments	Girth (cm)	Increment

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	cm	%
T0	6.3 ns	11.4 ns	20.5 b	31.0 b	37.6 b	41.7 b	35.4	100
T1	6.4 ns	12.6 ns	22.2 a	33.8 a	40.2 a	43.6 ab	37.1	105
T2	6.2 ns	11.2 ns	21.1 ab	33.1 a	39.7 a	43.7 ab	37.5	106
T3	6.3 ns	11.7 ns	21.9 a	34.1 a	40.5 a	43.9 a	37.6	106

ns = Non-significant difference of average value among treatments ($p>0.05$).
a, b = Significant difference of average value among treatments ($p<0.05$)
Six years after the commencement of the experiment (2010) the mean girth of the rubber ranged significantly from 41.7 cm in the control to 43.9 cm with the fertilizer application (Table 3). The cumulative girth increment for a period of six years (2011-2016) in T3 treatment (37.6 cm) was slightly higher after 6 years of planting than T0 (35.4 cm), T1 (37.1 cm) and T2 (37.5 cm) treatments.

Girth at opening

The mean girths at opening (7 years old) were not significantly different between all treatments (Table 4). However, there is a trend as shown by the percentage of rubber trees that can be tapped at opening, which is increased by 7 to 13% with fertilizer applications.

Table 4. Percentage of rubber trees at opening

Treatments	Girth at opening (cm)	% of tapped trees at opening
T0	49.8	61
T1	49.7	74
T2	50.8	68
T3	50.9	73

Height measurements

The rubber heights of all treatments were comparable (Table 5). The rubber height increments in T1 treatment (2.60 m) was slightly higher after 3 years of planting than T0 (2.43 m), T2 (2.44 m) and T3 (2.44 m) treatments.

Table 5. Annual height and height increments during the immature period from year 1.5 to year 3 (in meters).

Treatments	Height (m)			Increment
	Year 1.5	Year 2	Year 3	
T0	3.74 ns	4.69 ns	6.17 ns	2.43
T1	3.83 ns	4.79 ns	6.42 ns	2.60
T2	3.70 ns	4.68 ns	6.14 ns	2.44
T3	3.79 ns	4.80 ns	6.23 ns	2.44

ns = Non-significant difference of average value among treatments ($p>0.05$).

The rubber height was not significantly different with all fertilizer treatments and was increased only by 0.2 m with the use of fertilizers. With the conditions of this trial, it seems that the height parameter is not sufficiently accurate.

4. Discussion and conclusion

After two years of fertilizer application, the treatment with fertilizer did not show significant difference in rubber girth (cm) compared to the no-fertilizer control treatment. These results are in agreement with the previous results of Sherin et al. (2004). The authors found no significant difference in plant growth due to application of fertilizers at one and two years after the commencement of the treatments. But from the third to the sixth year, the treatments with fertilizer showed significant difference in rubber girth (cm) compared to unfertilized. The girth increment of fertilizer treatments of the 6-year-old rubber trees were of 5 to 6% compared to the girths of unfertilized trees. These results confirm previous results shown by Yogaratnam et al. (1984). The authors found that, in the conditions of the experiment in Sri Lanka, fertilizer application on the immature period increased final girth of a 6-year-old trees by 2 to 19% compared to the girths of unfertilized trees.

In the conditions of our trial, we can presume that it may be thought that the soil phosphorus and cation contents of the control treatment were already adequate, which may explain that the fertilizer inputs did not have a significant effect on girth increment during the rooting phase (two first years). On the other hand, the nitrogen inputs were useful and enabled to make the difference between the control and fertilized treatments from third year to opening.

The rubber height was not significantly different with all fertilizer treatments and was increased only by 0.2 m with the use of fertilizers. With the conditions of this trial, it seems that the height parameter is not sufficiently accurate.

In the local conditions of this 7-years trial, it can be concluded that, fertilizer application can increase the girth (cm) by 6% and the percentage of tappable trees by 7-13%, but it is of utmost importance to take into account the soil nutrient levels to determine the fertilizer composition.

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5. Reference

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